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BATHYMETRY PROGRAM
KURILE ISLANDS EXPERIMENT

Special Report No. 3
OCEAN-BOTTOM SEISMOGRAPHIC EXPERIMENTS

Prepared by
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TEXAS INSTRUMENTS INCORPORATED
Science Services Division
P.O. Box 5621
Dallas, Texas 75222

28 April 1967

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ADVANCED RESEARCH PROJECTS AGENCY,
Nuclear Test Detection Office,
under Project VELA UNIFORM,
and accomplished under the technical direction of the
AIR FORCE TECHNICAL APPLICATIONS CENTER,
Contract No. F 33657-67-C-0105

Effective Date of Contract: 28 July 1966
Contract Expiration Date: 27 April 1967
Amount of Contract: $892,217

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ABSTRACT

A bathymetric survey was conducted as a part of the Kurile Islands Experiment (Ocean-Bottom Seismograph Experiments, Contract No. F 33657-67-C-0105). Since the primary efforts of the experiment were directed toward the Ocean-Bottom Seismograph and Explosive Program, the method used during the bathymetric survey was appropriate but not optimum. Bathymetric data were very good and were as reliable as navigation would permit. However, the profile coverage was generally too sparse. The conclusion is that observations of depth values, OBS-environmental relations and overall bathymetry are valid within navigational limits.

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SECTION I

INTRODUCTION

An Ocean-Bottom Seismograph experiment which investigated the seismicity of the area and evaluated the operational worthiness of the instrument, was conducted near the Kurile Islands during the fall of 1966. An explosive program was used to calibrate the instruments and to supplement natural seismicity. To aid in evaluating data, a bathymetric survey was conducted, with profile coverage controlled by Ocean-Bottom Seismometer and Explosive Program operations.

The objectives of this report are to explain observations made during current Kurile bathymetric analysis and to help formulate new ideas or substantiate old ones in interpretation of Kurile Arc geology.

SECTION II
SUMMARY OF THE SURVEY

The M/V Campeche Seal and M/V Pacific Seal were each equipped with an Ocean Sonics, Inc. GDR-T fathometer (Figure 1). Sounding records were obtained for 24 profiles in an area approximately 420 mi long and 250 mi wide from the northern tip of Hokkaido, Japan, northeast to Shasukotan Island of the Kurile Islands chain. Profile coverage was determined from OBS drop and recovery sights and explosion locations (Figure 2). Fathometer malfunction on the M/V Pacific Seal eliminated data collection in the near-island waters. The M/V Campeche Seal collected all 24 profiles; 11 traverse the trench and 16 traverse the shelf margin.

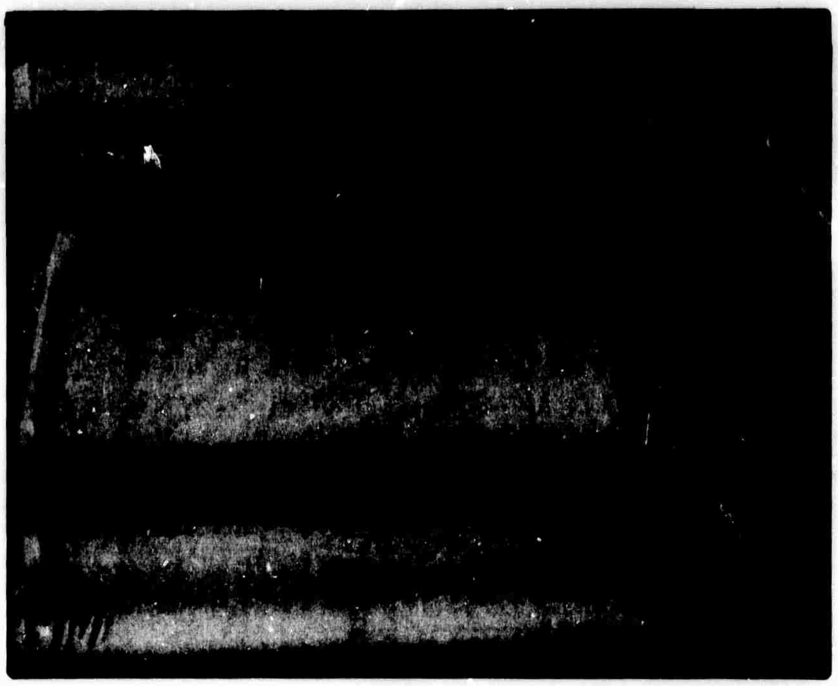


Figure 1. Ocean Sonics, Inc., GDR-T Fathometer

EVENT, SYSTEM, AND DEPTH PROFILE CHART

KURILE ISLANDS

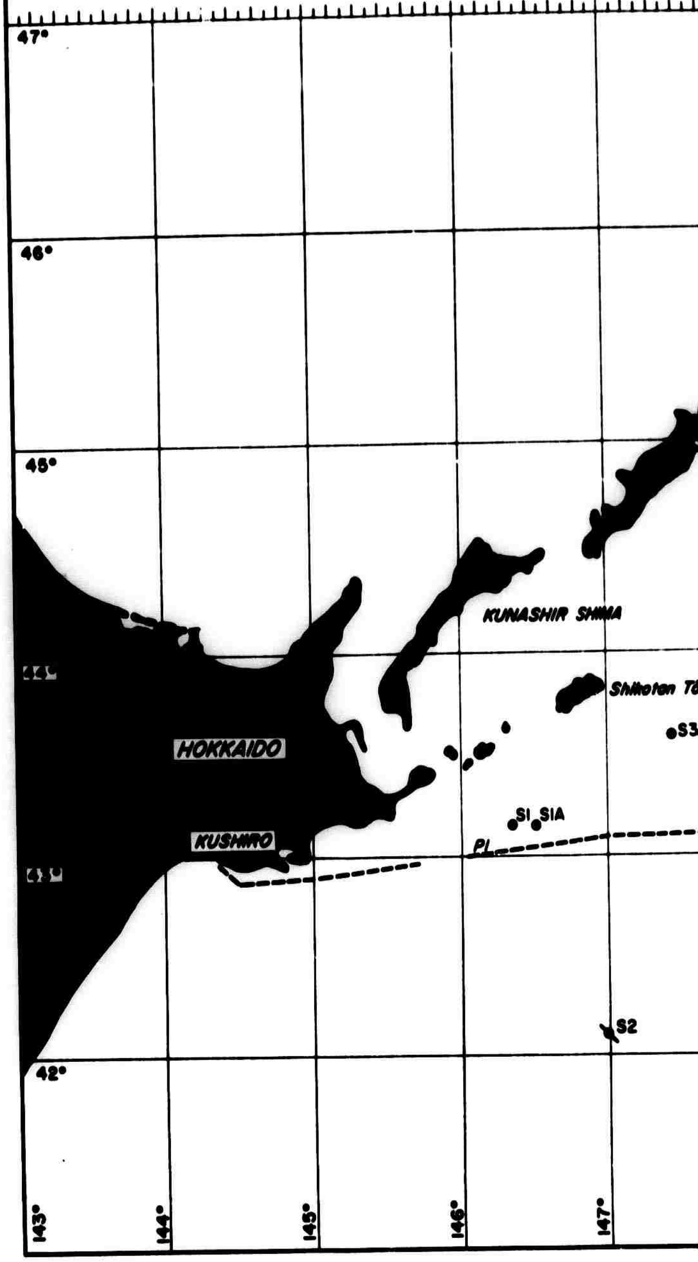
NORTH PACIFIC OCEAN

MERCATOR PROJECTION

SCALE: Based on Lat. 52° 30′

LEGEND:

○ EVENT LOCATION
● SYSTEM LOCATION
UNRECOVERED SYSTEM
P3 DEPTH PROFILE



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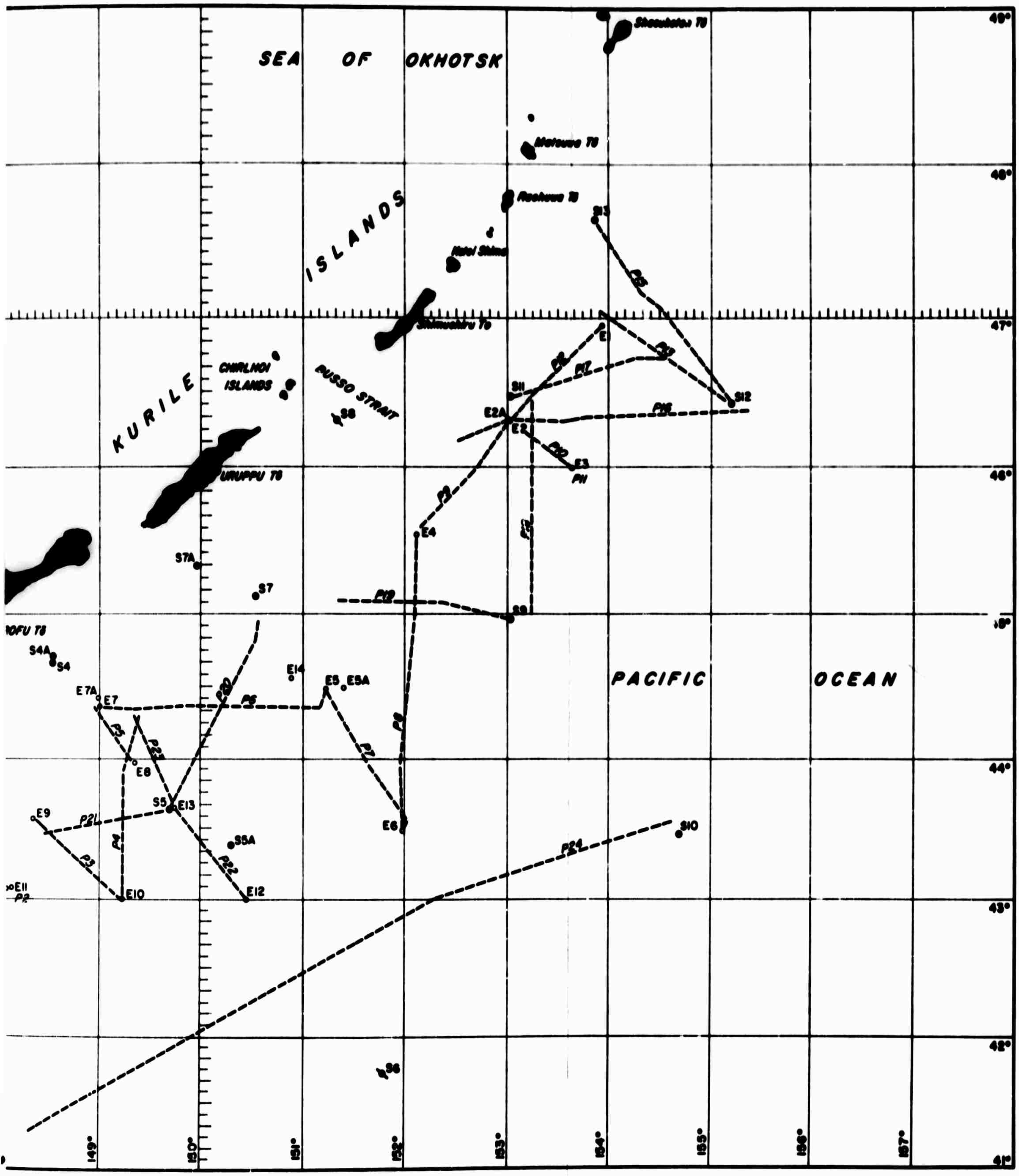


Figure 2. Event, System and Depth Profile Chart

B

Navigation was primarily controlled by dead-reckoning and celestial techniques including star fixes and sun lines and had an estimated 2- to 5-mi accuracy. Approximate positions for dead-reckoning were validated using the nearest reliable fix while taking into consideration weather conditions.

Depth-value interpretation was accurate to 20 fm ± navigational error with fathometer depths at event locations checked by computing travel-time data recorded with a marine geophone. Such a navigational error was indicated by the erratic values for computed depth readings of 98 fm above to 192 fm below the fathometer depths. Depth values (underlined in Figure 3) from previous surveys agreed with current data and were used to control the dashed contours which were used in areas this survey did not cover, including instrument positions not visited by M/V Campeche Seal. Instrument positions sounded (stations 5, 7, 9, 11, 12, 13, and 10; Figure 2) had depth accuracies based on navigation limits; however, actual instrument depths and geographical locations on the ocean bottom have not been validated. Table 1 gives depth-position reliability for those points indicated on profiles in Figure 4.

Two areas of comparatively reliable position and depth accuracy, due to better profile coverage, occur near 44°00'N, 149°30'E and 46°30'N, 153°00'E.

BATHYMETRY OF THE KURILE AREA

KURILE ISLANDS
NORTH PACIFIC OCEAN

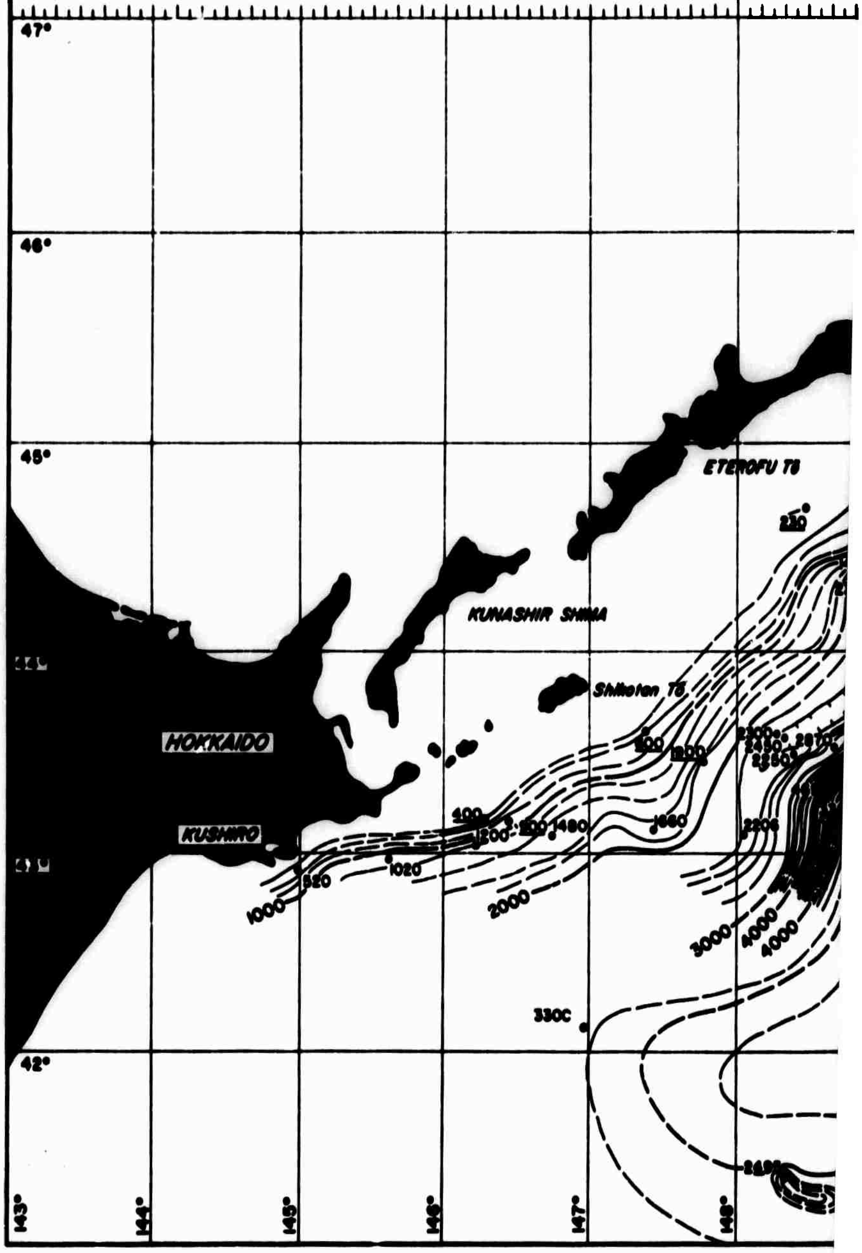
MERCATOR PROJECTION

SCALE: Based on Lat. 52° 30′

LEGEND:

CONTOUR INTERVAL – 200 FATHOMS

—o—o— TRENCH AXIS



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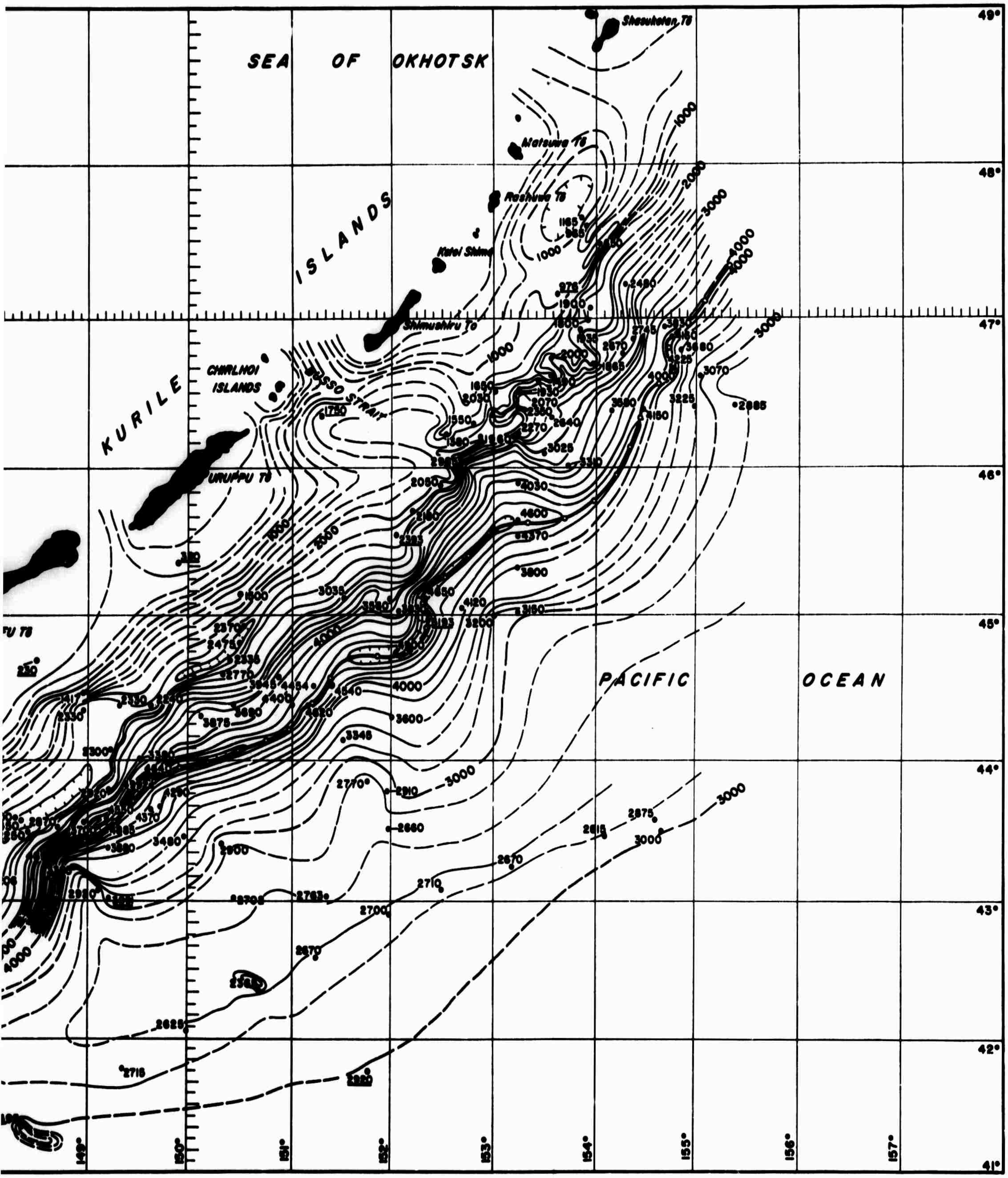


Figure 3. Bathymetry of the Kurile Area

Table 1

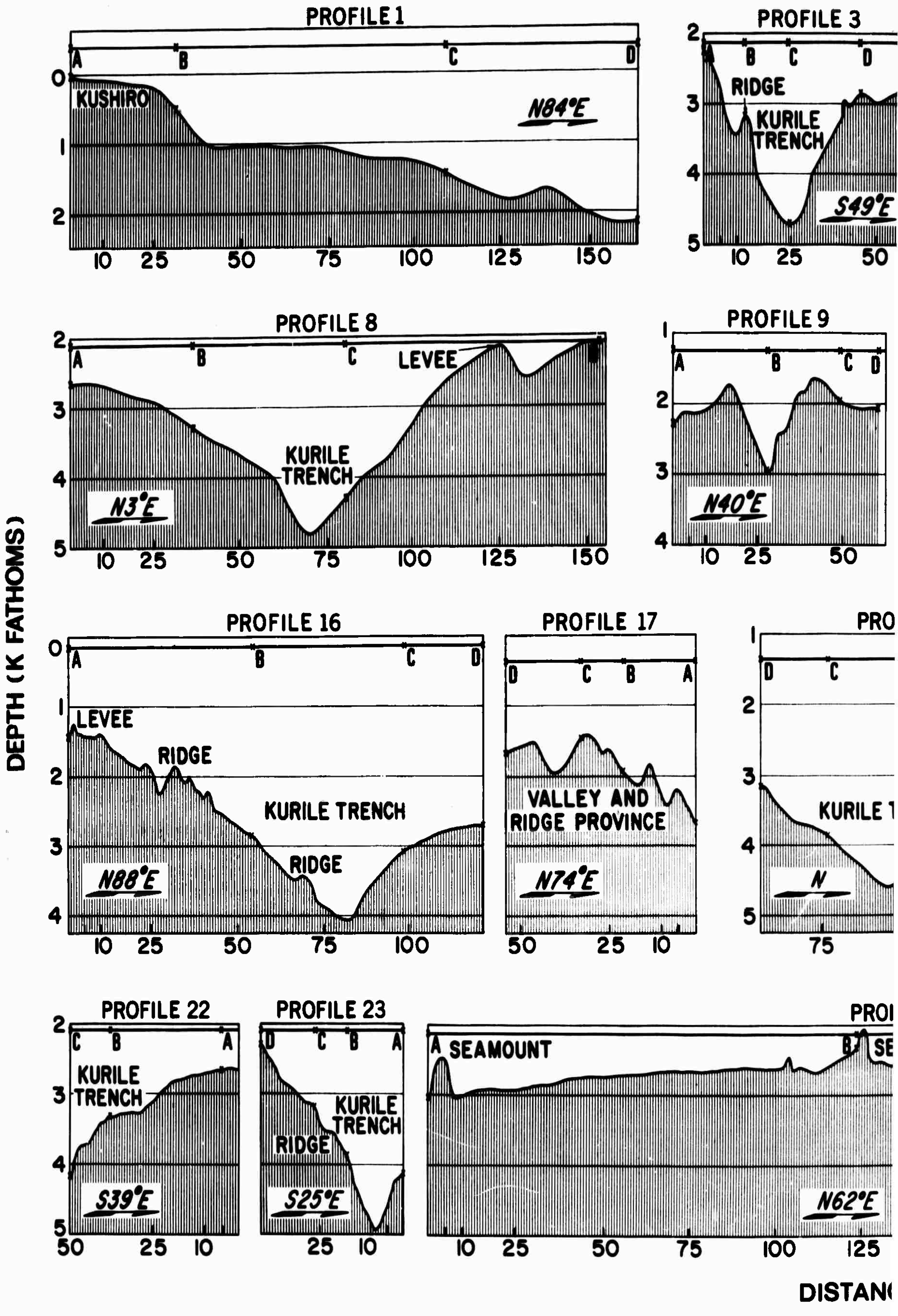
POSITION AND DEPTH RELIABILITY

Profile	Total Profile Rel.	Position A Lat. Long.	Position A Rel.* (mi)	Position A Depth** (fm)	Position B Lat. Long.	Position B Rel.* (mi)	Position B Depth** (fm)	Position C Lat. Long.	Position C Rel.* (mi)	Position C Depth** (fm)	Position D Lat. Long.	Position D Rel.* (mi)	Position D Depth**
1	Very Good	43°00' 144°22' ⊙●	± 1	3.8	42°55' 145°00' ⊙	± 1	520.0	43°05' 146°46' ○	± 2	1480.0	43°06' 148°00' ●	± 2	2130.0
3	Good	43°34' 148°20' ○	± 3	2300.0	43°27' 148°30' ○	± 3	3165.0	43°21' 148°41' ○	± 4	4695.0	43°09' 148°58' ○	± 5	2865.0
4	Good	43°01' 149°12' ●	± 3	3185.0	43°32' 149°11' ○	± 4	4885.0	43°47' 149°12' ○	± 5	2920.0	44°11' 149°18' ●	± 3	2210.0
5	Good	44°00' 149°20' ○	± 3	3018.0	44°05' 149°12' ○	± 4	2300.0	44°23' 148°58' ○	± 4	2300.0	–	–	–
6	Fair	44°23' 148°58' ○	± 4	2300.0	44°22' 149°18' ○	± 4	2330.0	44°23' 150°37' ○	± 3	3900.0	44°23' 151°09' ●	± 2	4620.0
7	Good	44°31' 151°15' ○	± 2	4500.0	44°20' 151°20' ○	± 3	3845.0	43°59' 151°36' ●	± 3	2890.0	43°35' 152°00' ○	± 3	2690.0
8	Good	43°31' 151°57' ○	± 3	2660.0	44°07' 151°57' ○	± 3	3285.0	44°52' 152°02' ○	± 3	4300.0	45°37' 152°02' ●○	+ 2	2140.0
9	Fair	45°37' 152°06' ○	± 2	2360.0	46°02' 152°40' ○	± 3	2985.0	46°13' 152°49' ○	± 3	1960.0	46°19' 152°58' ○	± 3	2215.0
10	Poor	46°20' 153°01' ○	± 4	2100.0	46°14' 153°13' ○	± 4	2270.0	46°06' 153°29' ○	± 4	3025.0	46°01' 153°41' ○	± 4	3310.0
12	Very Good	46°24' 153°04' ●	± 2	1940.0	46°40' 153°26' ○	± 3	1760.0	46°48' 153°38' ○	± 3	1720.0	46°59' 153°54' ●	± 2	1800.0
13	Good	47°04' 153°54' ●○	± 2	1900.0	46°46' 154°33' ○	± 3	3700.0	46°34' 154°58' ○	± 4	3180.0	46°28' 155°11' ○	± 5	2850.0
15	Good	47°39' 153°51' ⊙○	± 3	1165.0	47°13' 154°16' ○	± 4	2480.0	46°54' 154°42' ○	± 4	4000.0	46°28' 155°11' ○●	± 3	2850.0
16	Good	46°13' 152°20' ⊙	± 1	1520.0	46°22' 153°44' ●	± 2	2940.0	46°24' 154°57' ○	± 3	3225.0	46°26' 155°20' ○	± 4	2885.0
17	Fair	46°46' 154°14' ○	± 3	2670.0	46°40' 153°47' ○	± 3	1905.0	46°37' 153°32' ○	± 3	1490.0	46°31' 153°07' ○	± 4	1670.0
18	Fair	46°33' 153°12' ○	± 4	2365.0	45°54' 153°12' ○	± 4	4030.0	46°20' 153°12' ○	± 4	3800.0	45°00' 153°12' ●●	± 2	3150.0
19	Good	45°07' 150°48' ○	± 3	2610.0	45°06' 152°09' ○●	± 2	4650.0	45°00' 153°00' ○	± 3	3200.0	44°59' 153°07 ○	± 2	3180.0
20	Good	45°00' 150°32' ○	± 3	2135.0	44°45' 150°25' ●	± 3	2430.0	44°04' 149°55' ○	± 4	4340.0	43°45' 149°42' ●	± 2	4640.0
21	Fair	43°40' 149°40' ●○	± 2	4315.0	43°37' 149°18' ○	± 3	4920.0	43°31' 148°42' ○	± 4	3090.0	43°30' 148°24' ○	± 4	2080.0
22	Good	43°02' 150°25' ○●	± 1	2645.0	43°32' 149°52' ○	± 2	3460.0	43°39' 149°42' ○	± 2	4200.0	–	–	–
23	Good	43°41' 149°43' ●	± 1	4160.0	43°57' 149°32' ○	± 2	3905.0	44°19' 149°20' ○	± 2	3200.0	44°19' 149°20' ●○	± 3	2295.0
24	Very Good	41°15' 148°14' ●	± 1	3085.0	42°20' 150°40' ○	± 2	2365.0	43°02' 152°14' ●	± 1	2685.0	43°29' 154°05' ○●	± 3	2815.0

* Reliability limits are estimates of position accuracy considering
- Nearest reliable fix (celestial, Loran and/or radar)
- Weather conditions during fix and voyage traverse
- Length of dead-reckoning and speed of traverse
- Combinations of any of the above

** Soundings are uncorrected for velocity gradient and subject to correction within limits imposed by position accuracy.

- ● Star fix
- ◉ Loran fix
- ⊙ Radar
- ● Dead-reckoning and sun line
- ○ Dead-reckoning



PROFILE 1
KUSHIRO
N84°E
PROFILE 3
RIDGE
KURILE TRENCH
S49°E
PROFILE 8
LEVEE
KURILE TRENCH
N3°E
PROFILE 9
N40°E
DEPTH (K FATHOMS)
PROFILE 16
LEVEE
RIDGE
KURILE TRENCH
RIDGE
N88°E
PROFILE 17
VALLEY AND RIDGE PROVINCE
N74°E
PRO
KURILE T
N
PROFILE 22
KURILE TRENCH
S39°E
PROFILE 23
KURILE TRENCH
RIDGE
S25°E
PROI
SEAMOUNT
SE
N62°E
DISTAN

A

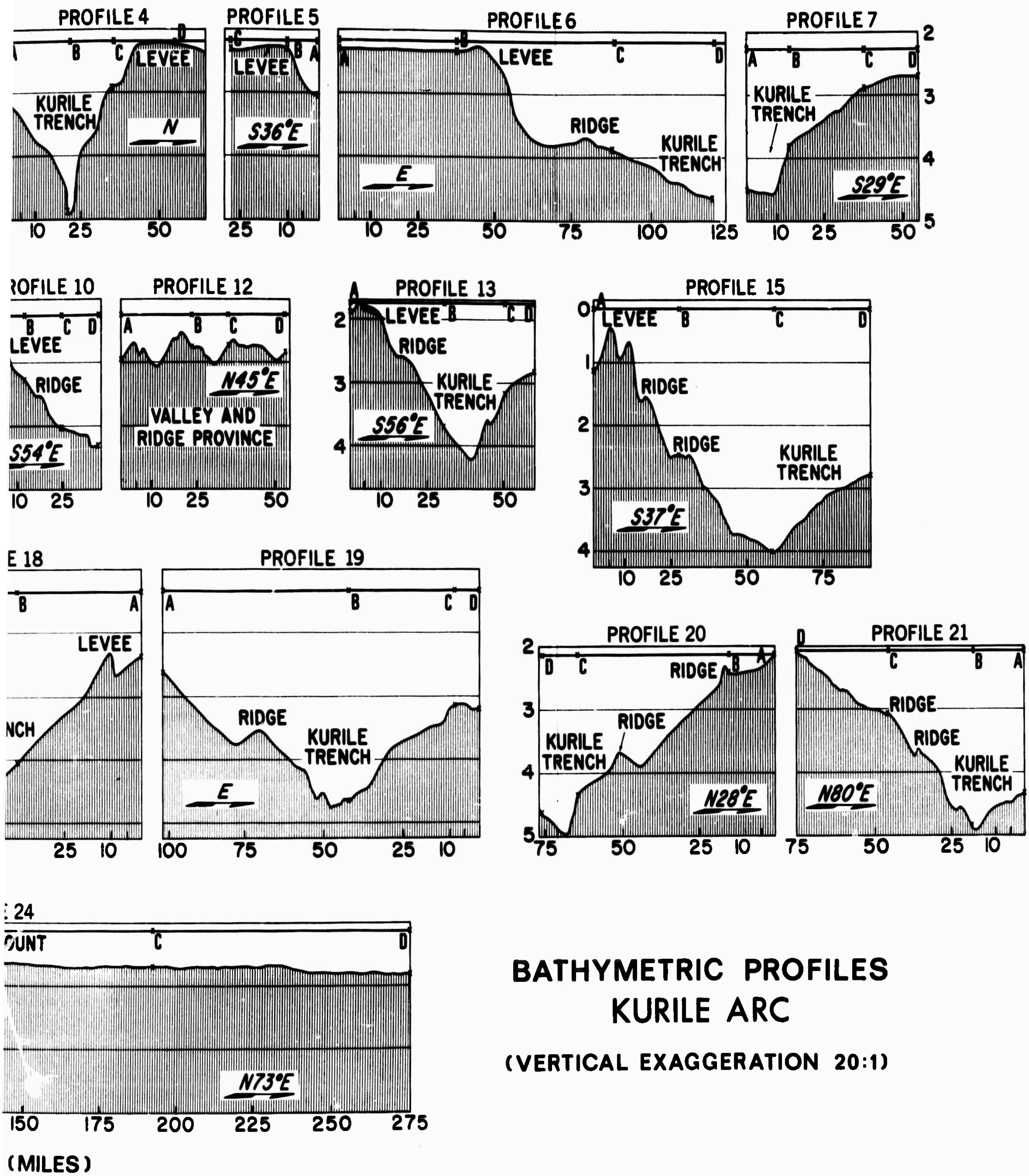


Figure 4. Bathymetric Profiles — Kurile Area

B

SECTION III
DATA ANALYSES

Bathymetric data analyses indicate the shelf, shelf margin, and slope areas of the Kurile Trench to be more complex than previously mapped. A submarine canyon, or valley, originating between Shimushiru Island and the Chirlhoi Islands (profile 9, Figure 4) is the dominant feature of a valley and ridge complex consisting of a smaller valley entering the trench to the northeast and a shelf margin cut by several valley and ridge features (profiles 12 and 17). Southwest of the canyon, the shelf appears to be smooth and has a consistent dip down to the shelf margin. Soundings across the shelf margin (profiles 6, 8, 10, 13, 15, 16, and 20) indicate a leveed or ridged marginal area.

The continental slope varies in dip from 4° to 10°. Two secondary ridge or bench-like features appear at approximately 800-fm intervals down the otherwise smooth slope (profiles 15, 19, 20, and 21).

Measurements taken at the 4000-fm level indicate an average trench width of 20 mi, narrowing to approximately 3 mi on profile 15 and widening to 30 mi on profiles 8 and 18. This survey recorded a maximum depth of 4992 fm at 43°48'N, 149°38'E. (Depths shown on the bathymetric chart, Figure 3, are uncorrected; i.e., the velocity of sound in water is assumed to be 4800 fps.)

A noticeable increase in slope and considerable narrowing occur in the last several hundred fathoms of trench depth. Above this area, a more gradual outer slope of 2°to 3° ends in a low rise leveling off on the abyssal plain. Two seamounts were sounded on profile 24, but the extent of these features was not determined due to poor profile coverage.

The following paragraphs describe the bathymetry of OBS locations:

- Positions S1 and S1A (Figure 2) are on the gradual-sloping shelf region in 400 and 900 fm of water, respectively, approximately 20 mi from land. Depth comparisons at S3A-S3 and S7-S7A indicate a 3° to 4° dip for this region.
- Positions S4, S4A and S7A are at approximately 230, 230 and 330 fm in near-island waters not covered by this survey.
- Position S8 is approximately 20 mi from land, as are S4, S4A and S7A, but is at 1750 fm, which is much deeper. This position falls within the boundaries of the canyon seen in profile 9 (Figure 4). Unit 23, dropped at this position, was not recovered, possibly due to the canyon's rough topographic characteristics.
- Positions S11 and S13 are located at 1650 and 1320 fm, respectively, in the valley and ridge complex previously mentioned. S13 is on a gradual slope, while S11 appears to be on the marginal rim. Depth comparisons at positions S5 and S5A show a dip of 2° to 3° for the outer-slope area.

- Position S5 at 4370 fm was the deepest OBS position and is approximately 9 mi southwest of the trench axis. This area is relatively smooth and has a gradual slope offering minimum interference to OBS operations.

- Positions S9 at 3200 fm, S12 at 2850 fm, and S5A at 3100 fm (26, 23, and 35 mi, respectively, from the trench axis) are associated with similar bathymetry on the outer slope approaching the abyssal plain.

- Position S10 at 3000 fm was the most remote OBS from which data were obtained, being approximately 132 mi southeast of the trench axis. Unit 12 at position S6, 160 mi southwest of S10, at 2920 fm, was not recovered. Both positions were in the flat, relatively featureless abyssal-plain region.

- Position S2 remains poorly defined in bathymetry and seismicity due to the absence of bathymetric data and failure to recover the unit.

Of the 18 units launched, 13 recorded usable data from which more extensive studies related to bathymetry will be made. Continued improvement of depth and position accuracy will offer more reliable bathymetric interpretation of these data.

SECTION IV
CRITIQUE

The general objective of this phase of the experiment was to provide bathymetric data with sufficient accuracy and reliability to verify or support OBS data interpretation. Primary efforts of the experiment were directed toward the Ocean-Bottom Seismograph and Explosive Program operations, with bathymetry as a secondary objective. Therefore, the method was appropriate but not optimum for a bathymetric survey.

Bathymetric data were very good and were as reliable as navigation would permit. Generally, however, profile coverage was too sparse; two exceptions were in areas of greater OBS activity where profile orientation became the problem.

The conclusion is that observations of depth values, OBS-environmental relations and overall bathymetry are valid within navigational limits.

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13. ABSTRACT

A bathymetric survey was conducted as a part of the Kurile Islands Experiment (Ocean-Bottom Seismograph Experiments, Contract No. F 33657-67-C-0105-P002). Since the primary efforts of the experiment were directed toward the Ocean-Bottom Seismograph and Explosive Program, the method used during the bathymetric survey was appropriate but not optimum. Bathymetric data were very good and were as reliable as navigation would permit. However, the profile coverage was generally too sparse. The conclusion is that observations of depth values, OBS-environmental relations and overall bathymetry are valid within navigational limits.

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Kurile Islands Experiment						
OBS-environmental relations						

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